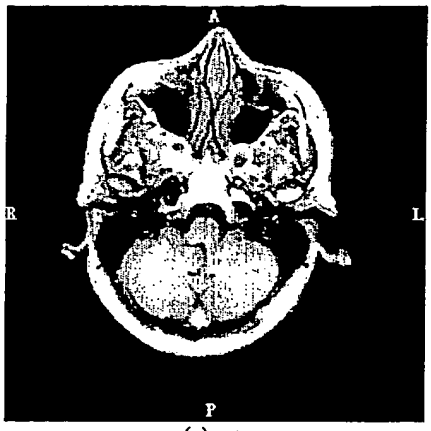
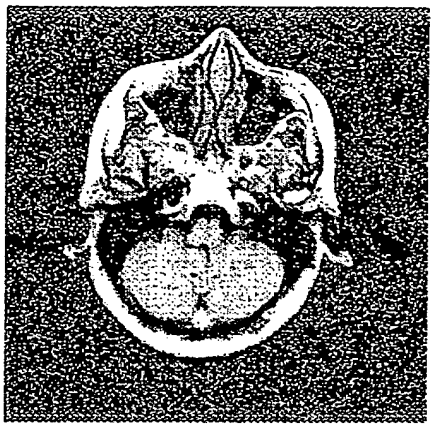
FIG. 1A



(a)

FIG. 1B



(b)

(PRIOR ART)

FIG. 2

200

+	-	+	-	+	-	+	-
-	+	-	+	-	+	-	+
+	-	+	-	+	-	+	-
-	+	-	+	-	+	-	+
+	-	+	-	+	-	+	-
-	+	-	+	-	+	-	+
+	-	+	-	+	-	+	-
-	+	-	+	-	+	-	+

FIG. 3

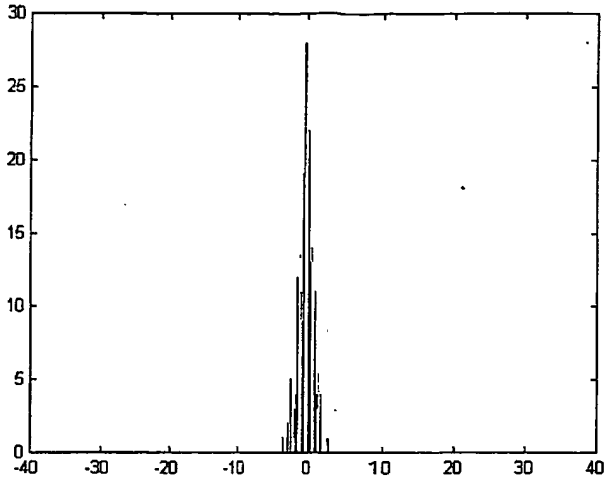


Figure 3: the distribution of the difference value α.

FIG. 4

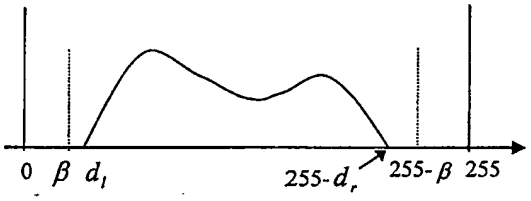


FIG. 5

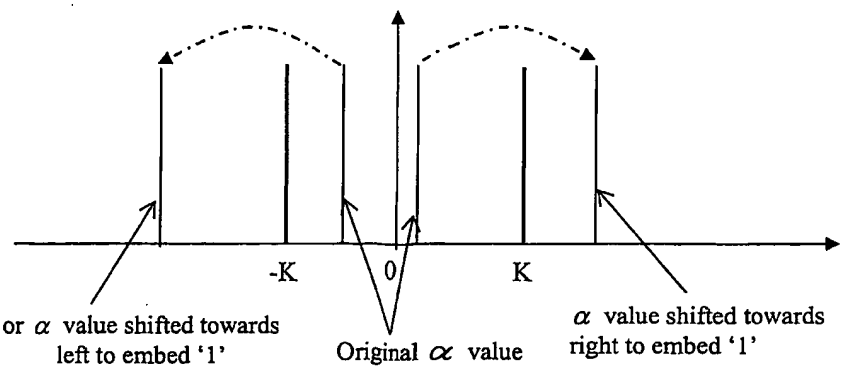


FIG. 6

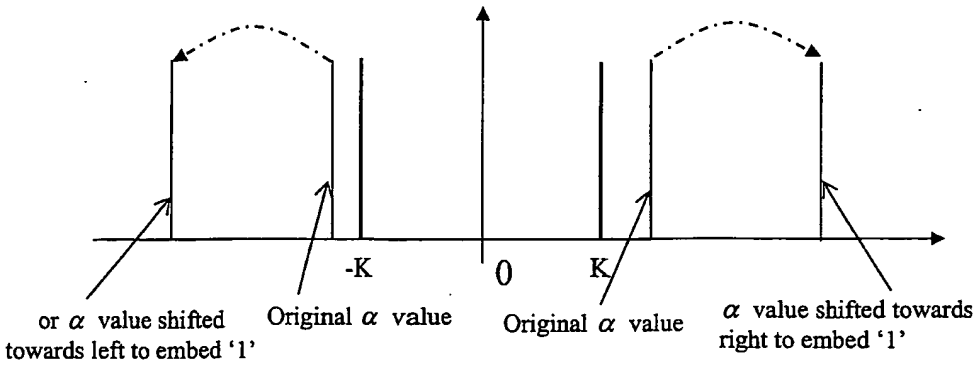


FIG. 7

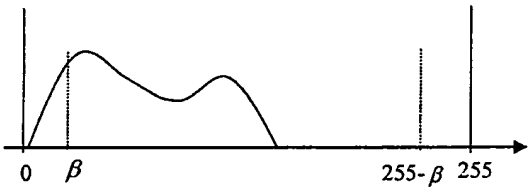


FIG. 8

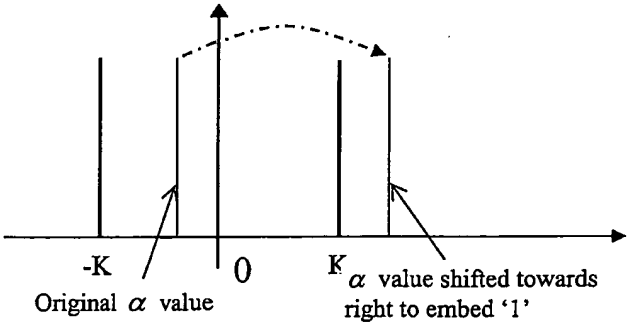


FIG. 9

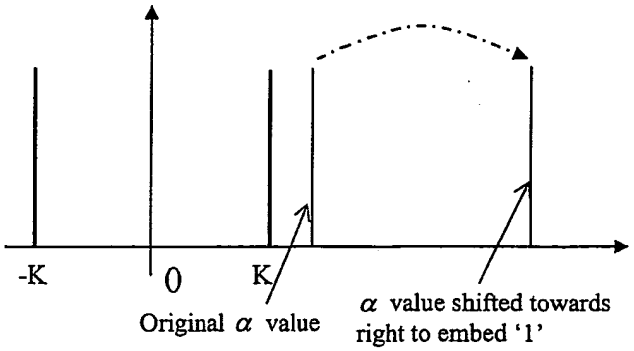


FIG. 10

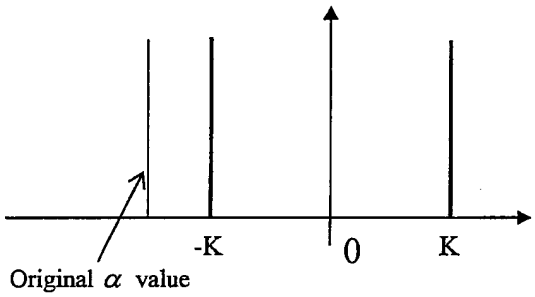


FIG. 11

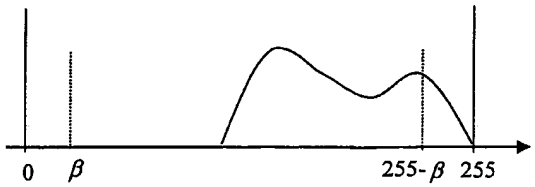


FIG. 12

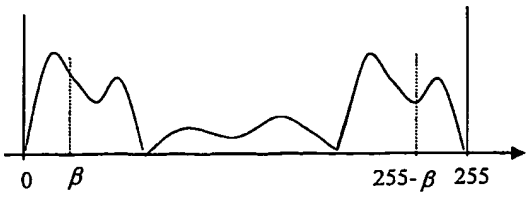


FIG. 13

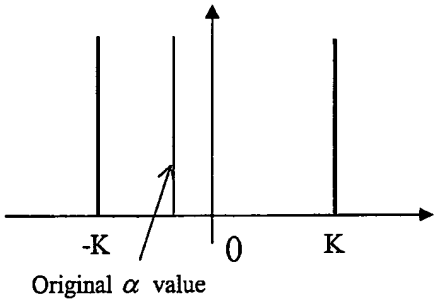


FIG. 14

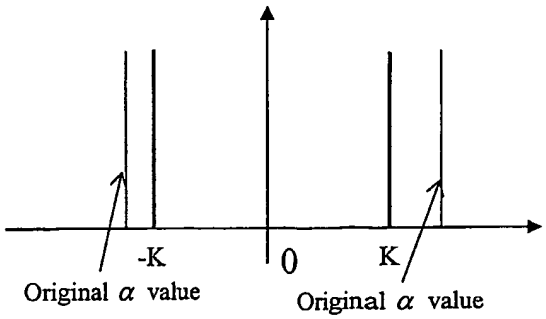


FIG. 15

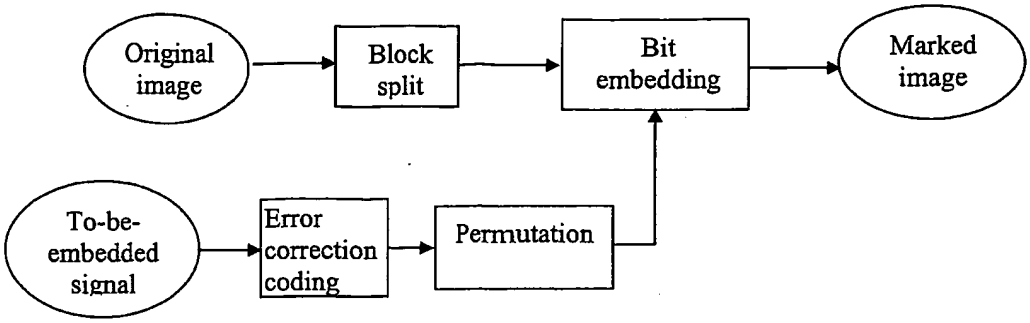


FIG. 16

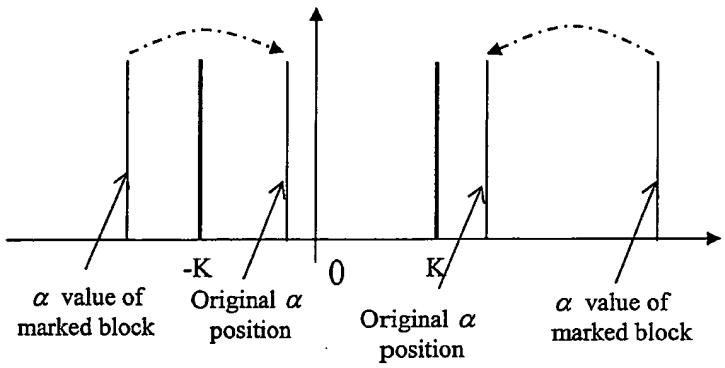


FIG. 17

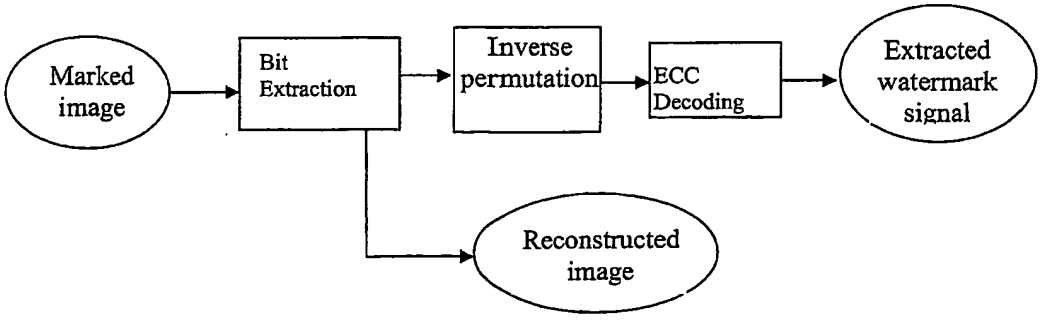


FIG. 18A

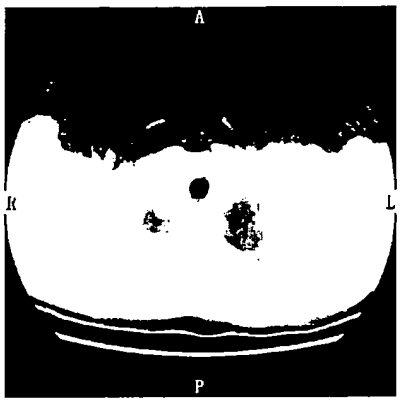


FIG. 18B

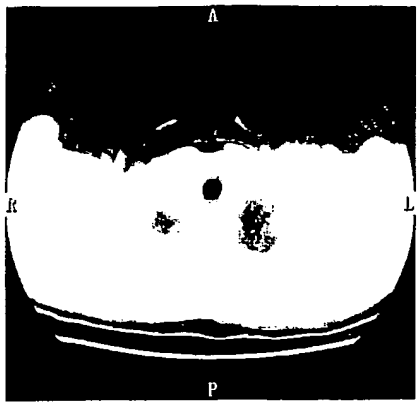


FIG. 19A

FIG. 19B

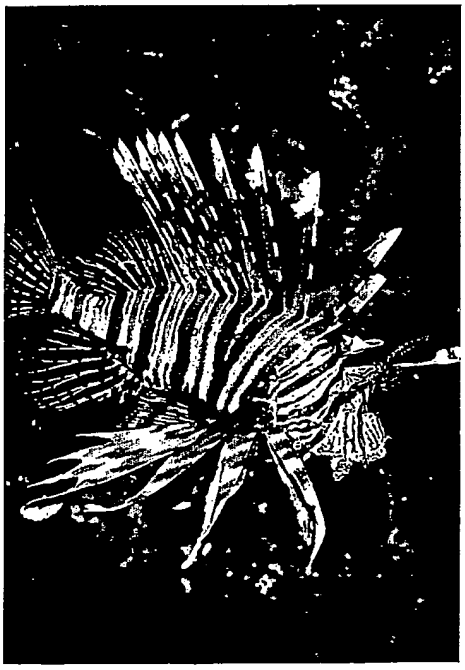


FIG. 20A

FIG. 20B

FIG. 21

	Lena	Baboon	Boat
PSNR (dB)	40.2	38.7	40.5
Capacity (bits)	792	585	560
Robustness (bpp)	0.8	1.6	1.0

FIG. 22

Images (512×768)	PSNR of marked image (dB)			Data embedding capacity (bits)	Robustness (bpp)		
	Max	Min	Avg	714	Max	Min	Avg
	45.2	37.4	40.2		2.0	0.2	1.21

FIG. 23

Images (512×512)	PSNR of marked image (dB)	Data embedding capacity (bits)	Robustness (bpp)
Mpic1	37.6	100	0.4
Mpic2	37.7	100	0.8
Mpic3	37.6	100	0.4
Mpic4	37.6	100	0.8
Mpic5	37.6	100	0.4
Mpic6	37.6	100	1.2
Mpic7	37.6	100	0.4
Mpic8	37.6	100	0.8

FIG. 24

Images (1536×1920)	PSNR of marked image (dB)	Data embedding capacity (bits)	Robustness (bpp)
N1A (Woman)	41.5	1410	0.8
N2A	41.3	1410	1.2
N3A	41.3	1410	0.8
N4A	41.4	1410	0.8
N5A	41.3	1410	0.8
N6A	41.2	805	0.4
N7A	41.2	1410	0.8
N8A	41.2	805	1.2

FIG. 25

			Mpic1		Mpic2		Mpic3		Mpic4		Mpic5		Mpic6		Mpic7		Mpic8	
	Block size	Embed level	PSNR (dB)	Robustness	PSNR (dB)	Robustness	PSNR (dB)	Robustness	PSNR (dB)	Robustness	PSNR (dB)	Robustness	PSNR (dB)	Robustness	PSNR (dB)	Robustness	PSNR (dB)	Robustness
Proposed algorithm	8	4	40.5	0.4	40.7	0.8	40.6	0.8	40.6	0.8	40.6	0.8	40.5	1.2	40.5	0.4	40.5	0.8
		6	37.6	0.4	37.7	0.8	37.6	0.4	37.6	0.8	37.6	0.4	37.6	1.2	37.6	0.4	37.6	0.8
		8	35.4	0.4	35.6	0.8	35.5	0.4	35.4	0.4	35.4	0.4	35.5	0.8	35.4	0.4	35.4	0.4
		10	33.7	0.4	33.8	0.4	33.7	0.4	33.7	0.4	33.7	0.4	33.7	0.8	33.7	0.4	33.7	0.4
	12	4	40.7	0.4	40.9	0.8	40.7	0.4	40.7	0.8	40.7	0.8	40.8	1.2	40.7	0.4	40.7	0.8
		6	37.8	0.4	38	0.8	37.8	0.4	37.8	0.8	37.8	0.4	37.9	1.2	37.8	0.4	37.8	0.8
		8	35.5	0.4	35.6	0.8	35.7	0.4	35.6	0.4	35.6	0.4	35.7	0.8	35.6	0.4	35.6	0.4
		10	33.8	0.2	34.1	0.4	33.8	0.2	33.8	0.4	33.8	0.2	34	0.8	33.8	0.2	33.8	0.4
	16	4	40.6	0.4	40.9	0.8	40.6	0.4	40.6	0.8	40.6	0.4	40.7	1.2	40.6	0.4	40.5	0.8
		6	37.7	0.2	38	0.4	37.7	0.2	37.7	0.4	37.7	0.2	37.8	0.8	37.6	0.2	37.6	0.4
		8	35.5	0.4	35.9	0.8	35.5	0.4	35.5	0.4	35.5	0.4	35.6	0.8	35.5	0.4	35.4	0.4
		10	33.8	0.2	34	0.4	33.8	0.2	33.8	0.4	33.8	0.2	33.9	0.8	33.8	0.2	33.7	0.4
Algorithm in [9]	8	4	9.9	1.6	4.9	1.6	29.0	1.2	29.1	0.8	29.1	1.6	5.8	2.0	10.1	0.8	6.2	1.2
		6	9.9	0.8	4.9	1.6	28.1	0.8	28.2	0.4	28.2	0.8	5.9	2.0	10.5	0.8	6.3	1.6
		8	9.9	0.8	5.0	2.0	27.1	0.8	27.2	0.4	27.2	1.6	5.9	1.6	10.3	0.8	6.3	2.0
		10	9.8	1.6	5.1	1.6	26.1	0.8	26.2	0.4	26.2	0.8	6.0	2.0	7.8	0.8	6.4	2.0
	12	4	10.1	0.8	5.0	1.6	28.0	0.8	28.2	0.8	28.6	1.2	6.0	2.0	10.8	0.8	6.4	1.6
		6	10.1	0.8	5.1	1.6	27.2	0.4	27.5	0.2	27.8	0.2	6.0	2.0	10.8	0.4	6.4	1.6
		8	10.1	0.8	5.1	2.0	26.4	0.8	26.6	1.6	26.8	0.4	6.1	2.0	10.6	0.8	6.5	0.8
		10	9.9	0.8	5.2	2.0	25.6	2.0	25.7	0.4	26.0	0.2	6.1	2.0	8.0	0.8	6.5	0.8
	16	4	10.6	0.8	5.3	1.6	29.0	0.8	29.2	0.8	29.2	0.4	6.4	1.2	11.2	0.8	6.9	1.2
		6	10.6	0.8	5.4	0.8	28.2	2.0	28.3	0.2	28.3	0.2	6.4	0.8	11.3	0.4	7.0	0.8
		8	10.6	0.8	5.4	1.6	27.3	0.8	27.4	0.4	27.4	0.4	6.5	1.6	11.1	0.8	7.0	0.8
		10	10.4	0.8	5.5	0.8	26.3	0.2	26.4	0.2	26.4	0.2	6.5	0.8	8.1	0.4	7.0	0.8

FIG. 26

	Block size	Embedding level	Average PSNR (dB)			Average robustness (bpp)		
Proposed algorithm	8	4	40.5	36.8*	36.9**	0.75	0.59*	0.53**
		6	37.6			0.65		
		8	35.4			0.5		
		10	33.7			0.45		
	12	4	40.7	37.0*		0.7	0.55*	
		6	37.8			0.65		
		8	35.6			0.5		
		10	33.8			0.35		
	16	4	40.6	36.9*		0.65	0.46*	
		6	37.7			0.35		
		8	35.5			0.5		
		10	33.8			0.35		
Algorithm in [9]	8	4	15.5	15.0*	15.1**	1.35	1.24*	1.04**
		6	15.2			1.1		
		8	14.8			1.25		
		10	14.3			1.25		
	12	4	15.4	14.8*		1.2	1.09*	
		6	15.0			0.9		
		8	14.7			1.15		
		10	14.0			1.125		
	16	4	16.0	15.4*		0.95	0.78*	
		6	15.7			0.75		
		8	15.3			0.9		
		10	14.6			0.525		

FIG. 27

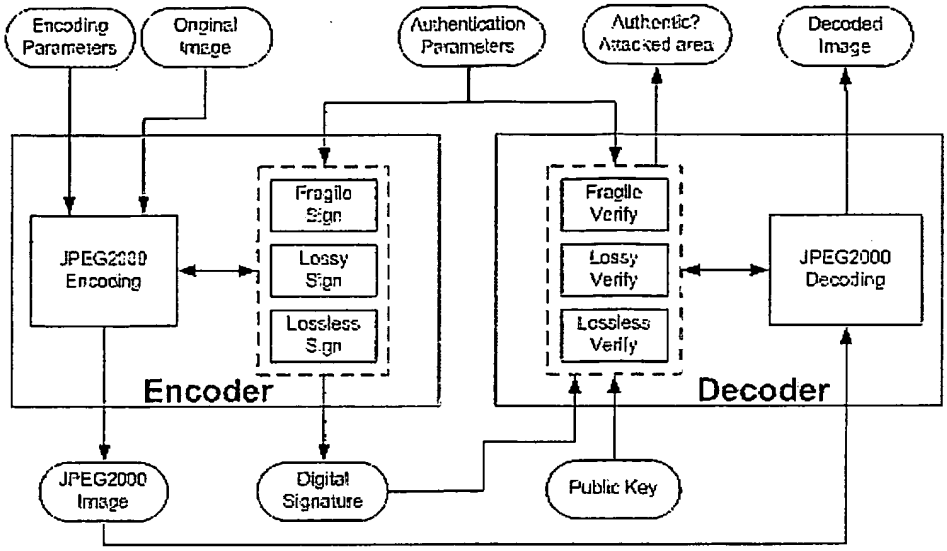

Encoding Parameters
Original Image
Authentication Parameters
Authentic? Attacked area
Decoded Image
JPEG2000 Encoding
Fragile Sign
Lossy Sign
Lossless Sign
Encoder
Fragile Verify
Lossy Verify
Lossless Verify
JPEG2000 Decoding
Decoder
JPEG2000 Image
Digital Signature
Public Key

FIG. 28

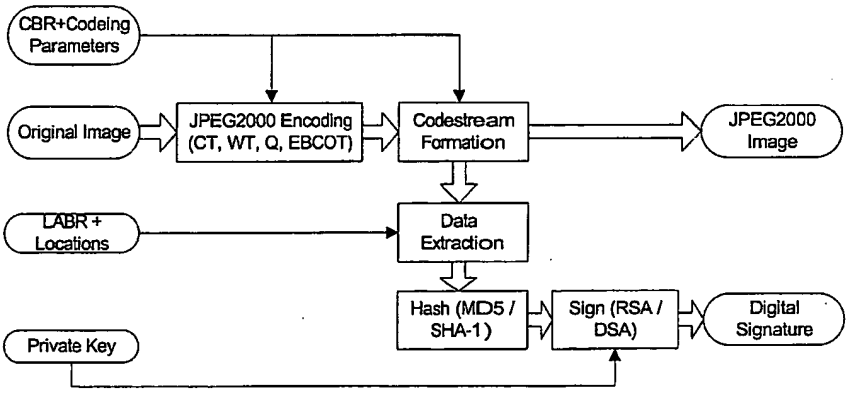

CBR+Codeing Parameters
Original Image
JPEG2000 Encoding (CT, WT, Q, EBCOT)
Codestream Formation
JPEG2000 Image
LABR + Locations
Data Extraction
Hash (MD5 / SHA-1)
Sign (RSA / DSA)
Digital Signature
Private Key

FIG. 29

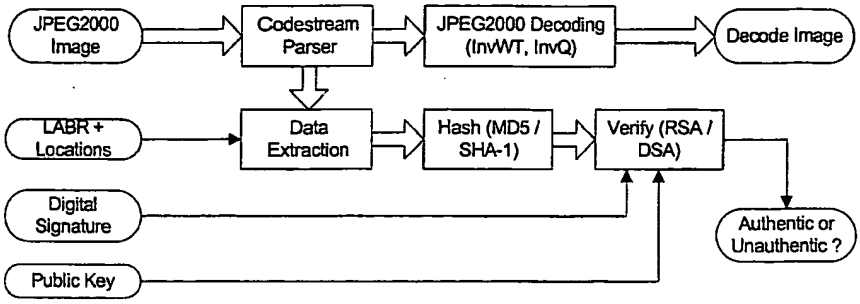

JPEG2000 Image
Codestream Parser
JPEG2000 Decoding (InvWT, InvQ)
Decode Image
LABR + Locations
Data Extraction
Hash (MD5 / SHA-1)
Verify (RSA / DSA)
Digital Signature
Authentic or Unauthentic ?
Public Key

FIG. 30

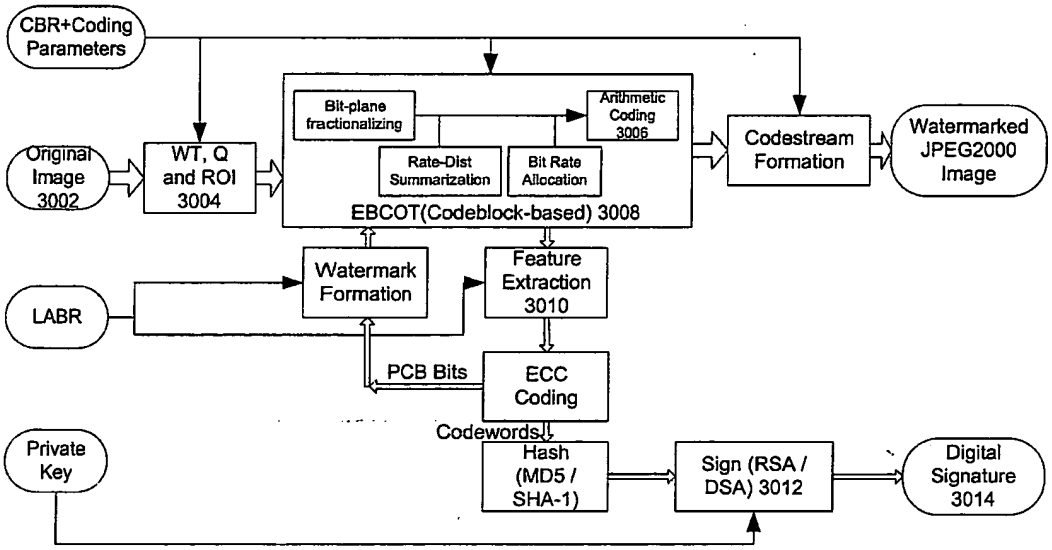

CBR+Coding Parameters
Original Image 3002
WT, Q and ROI 3004
Bit-plane fractionalizing
Arithmetic Coding 3006
Rate-Dist Summarization
Bit Rate Allocation
EBCOT(Codeblock-based) 3008
Codestream Formation
Watermarked JPEG2000 Image
LABR
Watermark Formation
Feature Extraction 3010
PCB Bits
ECC Coding
Codewords
Private Key
Hash (MD5 / SHA-1)
Sign (RSA / DSA) 3012
Digital Signature 3014

FIG. 31

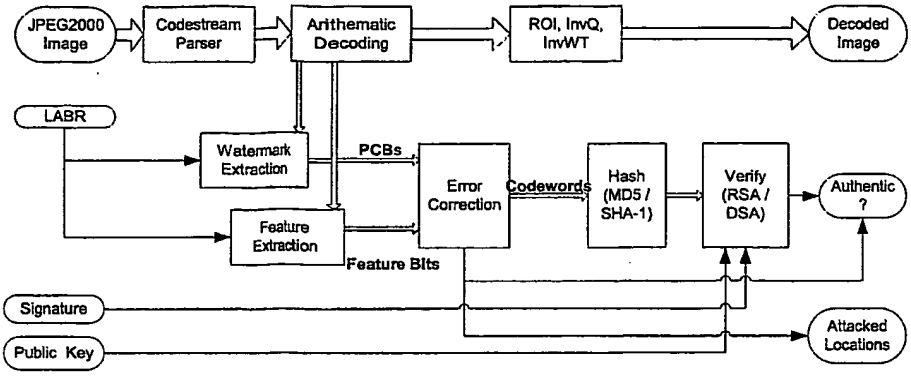

JPEG2000 Image
Codestream Parser
Arithematic Decoding
ROI, InvQ, InvWT
Decoded Image
LABR
Watermark Extraction
PCBs
Error Correction
Codewords
Hash (MD5 / SHA-1)
Verify (RSA / DSA)
Authentic ?
Feature Extraction
Feature BIts
Signature
Public Key
Attacked Locations

FIG. 32

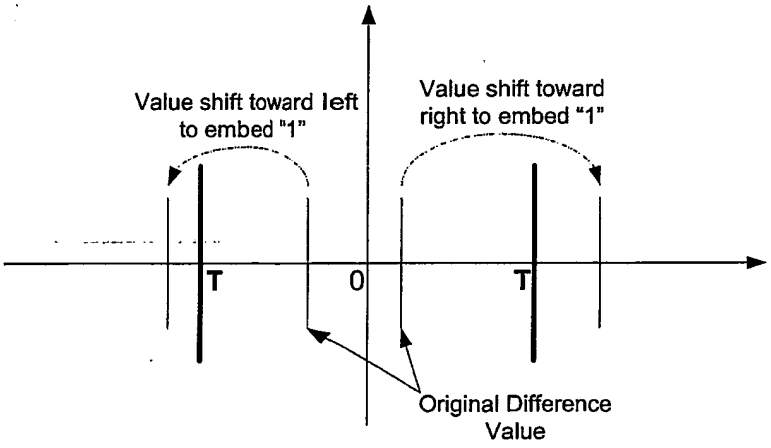

Value shift toward left to embed "1"
Value shift toward right to embed "1"
T
0
T
Original Difference Value

FIG. 33

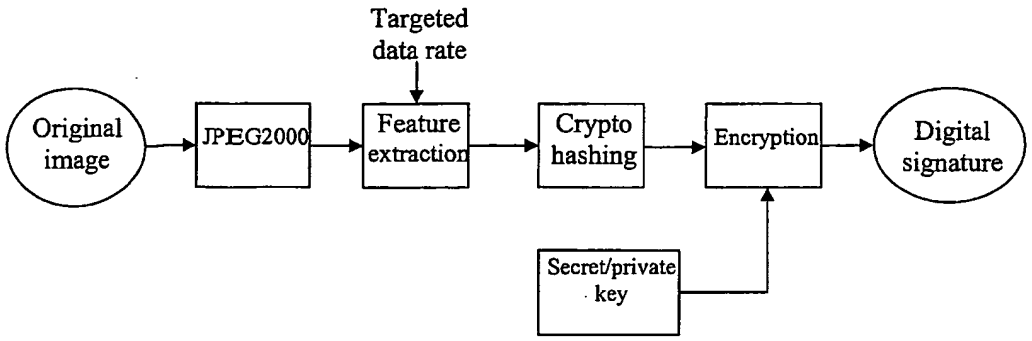
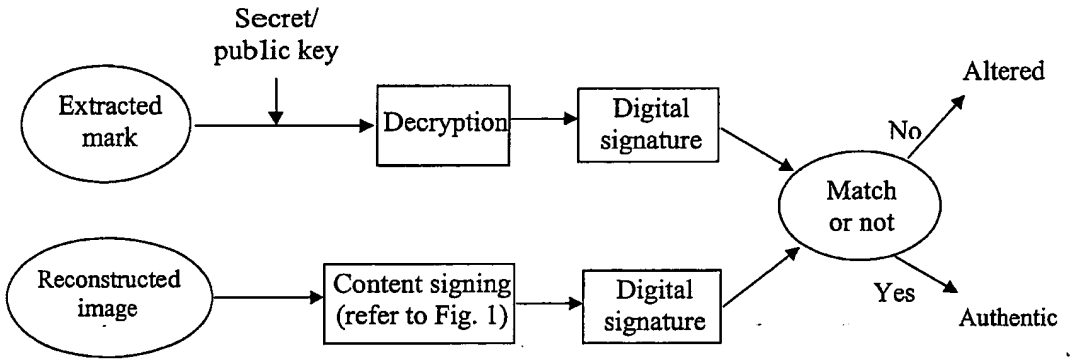

Targeted data rate
Original image
JPEG2000
Feature extraction
Crypto hashing
Encryption
Digital signature
Secret/private key

FIG. 34


Secret/ public key
Extracted mark
Decryption
Digital signature
Altered
No
Match or not
Reconstructed image
Content signing (refer to Fig. 1)
Digital signature
Yes
Authentic